U.S. Army Armament Research, Development, and Engineering Center (ARDEC) Update

Presented to

NDIA 42\textsuperscript{nd} Annual Armament Systems: Guns and Missile Systems Conference

25 April 2007
ARDEC Mission
Life Cycle Engineering & Support

Lightweight Dismounted Mortar
Excalibur
Lightweight Handheld Mortar Ballistic Computer, XM32
Supercritical Water Oxidation
M240B 7.62MM Machine Gun
40mm Multi-Shot Launcher
Plasma Arc Furnace
Lake City Army Ammunition Plant

...Providing Over 90% of the Army’s Lethality
• Established “Center of Mass” for Armament Systems and Munitions for Joint Services
• Proven track-record supporting transition of technologies to the field; since early FY 05.....
  • >28 Material Releases (MR) (>40 since early FY03)
  • >34 Urgent MR (>50 since early FY03)
• ARDEC Personnel ~ 3000; ~900 new hires since FY99
• >$100M invested in “World Class” experimental R&D facilities since mid-90’s; Additional $75M planned
• Strong partnerships with Industry, Academia, and other Government agencies.
• In-house rapid prototyping initiatives demonstrating new desired capabilities, supporting production prove-out and initial fielding demands
• >$125M Tech Base portfolio addressing Joint needs

2004 & 2006 Army Large R&D Lab of the Year
R&D and Experimentation Facilities

Major Examples

Davidson Advanced Warhead Development Facility
- Opened 1996
- $11.7M
- Maximum 50 TNT equivalent capability
- 100m indoor warhead test range

Armament Technology Facility
- Opened 2003
- $8.4M
- 2nd 100m range opening FY09
- 100 & 300m indoor ranges
- Environmental chambers

Precision Armaments Lab
- Opened 2000
- $8.8M
- 2 Lab grade elevators for sensor dev
- 3 Target locations; 150m, 400m, & 1500m

Armament Software Engineering Cntr
- Opened 2005
- Level 5 CMMI Certified
- $15.5M
- Integrated S/W & H/W development/integration
- Multi-platform SOSI highbay capability
New Facilities Under Construction
Breaking “Old” Grounds

Soft Recovery System (SRS)
- High-g test Munition/Components to 20K g’s
- 155mm capability (current); Only one in existence
- Navy 5”, 120mm mortar, and EM Gun planned

High Energy Propellant Formulation Facility
- 45,000 ft2 Propellant Pilot Plant
- Characterization Laboratories
- Magazine Storage / Offices

Pyrotechnic Research & Technology Complex
- 33,000 ft2 Engineering Offices & Laboratories
- Pilot manufacturing facility
- Energetic stowage

Explosives R&D Loading Facility
- 28,000 ft2 Melt Pour Operations & Engineering
- Climate Controlling Machining
- Explosive Pressing, Cast Cure, & X-Ray

Soft Recovery System (SRS): Opening May FY07
High Energy Propellant Formulation Facility: Opening FY08
Pyrotechnic Research & Technology Complex: Opening FY08
Explosives R&D Loading Facility: Opening FY09

Soft Recovery System (SRS): $9.0M
High Energy Propellant Formulation Facility: $17.7M
Pyrotechnic Research & Technology Complex: $9.9M
Explosives R&D Loading Facility: $8.0M
### Materiel Release Items
- Receiver, Radio Firing Device: M17 (Remote Activation Munitions System (RAMS))
- M1028 120mm Tungsten Canister Cartridge
- M278 2.75-inch IR Rocket with Mk66 Mod 4 Rocket Motor
- M232A1 Modular Artillery Charge System (MACS) 155mm Propelling Charge
- M777A1 155mm Medium Towed Howitzer
- M1040 105mm Canister Cartridge
- M782 Multi-Option Fuze Artillery (MOFA)
- Mk7 Mod 2 Anti-Personnel Obstacle Breaching System (APOBS), Tactical
- Mk7 Mod 2 APOBS, Training Aid
- M264 2.75-inch Red Phosphorous Smoke Screening Rocket with Mk66 Mod 3 Rocket Motor
- M720A1 60mm HE Mortar Cartridge with M734A1 Multi-Option Fuze
- M768 60mm HE Mortar Cartridge with M783 PD/DLY Fuze
- Mk243 Mod 0 9mm Jacketed Hollow-Point (JHP) Cartridge
- M255A1 2.75 inch Rocket Flechette Warhead with M439 RS Fuze and Mk66 Mod 4 Rocket Motor
- M111 Improved Position and Azimuth Determining System (IPADS)
- M107 Long Range Sniper Rifle

### Urgent MR Items
- XM110 Semi-Automatic Sniper System
- Enhanced M113A2 Rapid Entry Vehicle, Spirals 1 and 2
- USMC GG04 Rubber Ball Grenade (Army XM104)
- Advanced Combat Optical Gunsight (ACOG), Model TA31F (to USASOC, USAREUR, NGB, FORSCOM)
- Mk108 Mod 1 Signal Illumination Kit, Green Star – Pen Flare (30,000 to ARCENT-CFLCC)
- Mk135 Mod 1 Signal Illumination Kit, Various Color – Pen Flare (9,700 to ARCENT-CFLCC)
- Advanced Combat Optical Gunsight (ACOG), Model TA31RCO-M4 with LFU/ARD (to USASOC, USARPAC, NGB, FORSCOM, EUSA)
- M32 Lightweight Handheld Mortar Ballistic Computer (LHMBC) Version 2.1
- M927 105mm High Explosive Rocket Assist (HERA) Cartridge
- M100 Grenade, Rifle Entry Munition (GREM)
- M101 Grenade, Rifle Entry Munition – Target Practice (GREM-TP)
- Mk108 Mod 1 Signal Illumination Kit, Green Star – Pen Flare
- Mk142 Mod 0 Signal Illumination Kit, White Star – Pen Flare
- M1028 120mm Tungsten Canister Cartridge (to FORSCOM)
- XM328 40mm Multi-shot Grenade Launcher (MGL) (89 to ARCENT-CFLCC)
- Enhanced M113 – Rapid Entry Vehicle
### Materiel Release Items – Con’t…

- MK281 Mod 0 40mm Practice Cartridge
- M879 81mm Full Range Practice Mortar Cartridge
- M21 Modernized Demolition Initiator (MDI), Cap, Blasting, Non-Electric
- M192 Lightweight Ground Mount (LWGM)
- Paladin Digital Fire Control System (PDFCS)
- M240H 7.62mm Aviation Machine Gun
- M393A3 High Explosive Plastic with Tracer (HEP-T) 105mm Cartridge
- M467A1 Target Practice with Tracer (TP-T) 105mm Cartridge
- Paladin Software Version 7 for the M109A6 Howitzer Automatic Fire Control System (AFCS)
- M2 Vehicle Light-Weight Arresting Device (VLAD)
- M85 Trainer, Receiver, Radio Firing Device: M85 (Remote Activation Munitions System (RAMS) Trainer)

### Urgent MR Items – Con’t…

- XM1092 12 Gauge Extended Range Non-Lethal Marking Munition (ERNLMMs)
- XM1091 40mm Extended Range Non-Lethal Marking Munition (ERNLMMs)
- X26E Tasers, A.T. XP Air Cartridges and Digital Power Magazines
- Mk79 Mod 2 Signal Kit, Personnel Distress: Red Color – Pen Flare
- BBU-35/B Impulse Cartridge
- FN303 Less Lethal Launcher and Associated Equipment
- XM101 Common Remotely Operated Weapon Stations (CROWS)
- M930E1 120mm Illuminating Mortar Cartridge
- M278 2.75-inch IR Rocket with Mk66 Mod 4 Rocket Motor
- Matrix System plus spares
- Platoon-Size Non-Lethal Capabilities Set
- X26E Advanced Taser Weapon and Associated Equipment
- Heckler & Koch MP5-A5 and MP5K-PDW 9mm Submachine Guns
- M107 Long Range Sniper Rifle
- M203 Grenade Launcher Day Night Sight (DNS), Model 1800 Black with Tritium Sights
- Vehicle Lightweight Arresting Device
- Bradley Reactive Armor Tiles “A2” Vehicle Sets to ARCENT
- A2 Bradley Fighting Vehicle System Armor Tile Sets
Urgent Material Releases
Some Recent Examples

**M1028 120mm Canister Cartridge**
- New Anti-Personnel capabilities for Abrams Tank out to 500m+
- >15,000 rounds fielded to Army/Marines.

**M113A2 Rapid Entry Vehicle (REV)**
- Non-lethal response under armor with
  - 4 modified M870 shotguns
  - 6 Modular Crowd Control Munitions
  - 4 vehicles fielded

**M100 Rifle Launched Grenade Munition**
- Door Breaching Munition fired from M16A2 and M4 with standard 5.56mm M855 rounds.
- 300 tactical/1250 training rounds fielded

**M927 105mm High Explosive Rocket Assist (HERA) Cartridge**
- Extended range capability to 16km+ to meet critical mission need
- Combination new production and M913 conversion yielded ~3600 cartridges
- ~700 cartridges fielded
Rapid Prototyping Initiatives
Examples of “Tech Push” for Early User Demo’s AND Support to Production Requirements

Gunner’s Protection Kits (GPKs)

M114 Objective GPK (O-GPK)
- Concept Demo in 6 Months
- ARDEC Level III TDP
- Depot Production for >15K GPKs

RG31 GPK
- Modified O-GPK
- ARDEC LRIP underway

SOCOM GPK
- Expanded Requirements
- ARDEC LRIP underway

Sculpted Transparent Armor
- Curved Transparent Armor
- Enhanced Situational Awareness
- Concept demo planned May 07

Engineering Boat (MK1)
Survivability Enhancements
- Baseline Design Complete
- Prototype Demo Planned May 07
- LRIP Quantity Planned 3rdQ FY07

Close Coordination with Customers Key to an Integrated Solution for Survivability, Lethality, and Situational Awareness
Remote Armaments for Unmanned Platforms

Rapid Prototyping Initiatives
Examples of “Tech Push” for Early User Demo’s AND Support to Production/Fielding Requirements

**Remote Armament Sys Tech**
- Weapon designs specifically for unmanned platforms
- Ease of integration/functionality
- Concept demos FY08/09

**Key Design Challenges:**
- Weight/Cube/Power
- Weapon Re-arm/Automation
- Integration on COTS platforms
- Communications
- Roof and internal structures
- No fire zones / motion inhibits
- Vehicle dynamics
- EMI

**Initial Production Prove-Out and Safety Considerations to Apply to Remote Armament Programs**

**Picatinny LtWt Mount on TAGS**
- ARDEC in-house developed mount
- <200lb weight class with M240/M249
- 3 mounts supporting customer demos

**Special Weapon Observation-Reconnaissance Direct Action System (SWORDS)**
- Safety Confirmation Jun 06
- 3 Deployed to 3rd ID for Training
- Urgent Material Release expected

“I’m ready to deploy with this unit and SWORDS”
- SGT, 1-3 Cavalry, 3BDE/3ID

**Obj NLOS Mortar Technology**
- Elevating automated turret concept
- Demo on surrogate platforms FY07-09

**Tactical Amphibious Ground System (TAGS)**
- Safe built into system from the start
- 2007/2008 fielded
- Demo on surrogate platforms FY07-09

**Valuable Lessons Learned on Design and Safety Considerations to Apply to Remote Armament Programs**
**Engineering Analysis/Evaluation**

Example of evaluation of system technology performance

---

**Evaluation of Acoustic Sniper Detection Systems**

- **PURPOSE:** Validate accuracy of vehicle mounted gunfire detection systems, both statically and on the move *against vendor stated performance specifications*
  - Verify performance of system's ability to detect/locate sniper fire under various conditions
  - Verify system robustness to false alarms
- **Three-Phase Test at APG:**
  - Stationary – Open Field (Completed)
  - On the Move – Open Field (Completed)
  - Stationary – Urban Environment (May - Jun)
- **Emerging Results:**
  - System tested provide varying degrees of detect and locate capabilities
  - In general, discrepancies exist between vendor claimed performance specifications and test results
- **Specific platform testing requested by customers underway**

---

### SYSTEMS | MANUFACTURER
---|---
PD-Cue® 4 Corner | AAI
PD-Cue® Tetrahedral | AAI
Ferret | MacDonald Detwiller & Associates
VM-GDS | 01dB, Metravib
Boomerang v2.5 | BBN Technologies
SNIPOS | Axcess Technologies
VAAPS/LWAS | Land Warrior Acoustic Systems
Red Owl | iRobot

---

**Testing Critical for Requirements Generation and Establishing TTPs**
Recent Tech Base Transitions
Major Examples-Weapons

**LtWt 81mm Dismounted Mortar**
- Joint Army/Navy Funded
- ~30% weight reduction (to <70lbs)
- New Inconnel Tube Mat’l & Process
- Simpler, More Ergonomic Bi-Pod
- ~50% UPC reduction
- Transitioning to Prod ECP FY07

**XM325 120mm Mortar Cannon**
- 3 meter tube with screw block breech
- 8 km range with M900 series ammo
- Demonstrated 12 rpm firing rate (FCS Threshold Requirement)
- Transitioned to FCS Program at TRL 6

Selected Cannon by FCS Program
Recent Tech Base Transitions  
**Major Example-Ammunition**

**Line-of-Sight-Multi-Purpose (LOS-MP)**

**Current**
- M90B
- M630A1
- HEAT
- M1028

**Future - 1 Round**
- Simulated ATGM defeat 1000m
- 1-Shot T-55 Defeat
- 2 Shots - Defeat DRC
- 1 Shot Bunker Defeat

- Enhanced Lethality with One-Round against:
  - Concrete Wall
  - Earth and Timber Bunker
  - Lt Armor
  - Personnel

- LOS-MP TRL6 Exit Criteria met:
  - Defeated Double reinforced concrete wall with Hole size 30”x50” in <3 shots
  - Demonstrated greater than threshold range (700m) with potential to meet objective capabilities (40-2000m)

- Transitioned to PM-MAS
LOS-MP Design Process

- Initial conceptualization to meet requirements
- Definition of high risk process and long lead items
- Define shortfalls of M&S: Fill gaps with test, experience

Enabled TRL 6 Demo in 2 Years

Modeling/Configuration Pro Engineer/Intralink

IB Simulation IBHV$G^2$
Structural analysis FBD/ANSYS
Target penetration CTH

Fragmentation CALE/PAFRAG

Flight Performance

Failure in any model reiterates design process

No iteration of design during testing!

Lethality Models CASRED/MPR3D/AJEM/MUVES

3D numerical control Pro Manufacture

DR concrete wall

Modeling and Simulation Saved $6.8M and 27 Months
ARDEC Tech Base Investments
Some Examples w/ Joint Service Applications

Hardened Combined Effects Penetrator Warheads (FY04-08)
- Single warhead to defeat armor, bunkers, personnel, UAVs with capability to bash-through and detonate within urban structures and clear re-bar.
- Broad applications across guns and missiles

~$38M

LtWt Small Arms Technologies (FY05-08)
- Technologies to reduce weight, increase reliability, and decrease training burden
- Plastic cased and caseless ammo under evaluation
- 35-45% total weapon/ammo weight reduction in 5.56mm achievable (Baseline: M249)

~$35M

Electromagnetic Gun (FY04-08+)
- Subsystem technology maturation focus
- Enables next level of mission area analysis to support Army program path forward decisions
- Broad weapon mission applications across Services
- Army/Navy collaboration

$85M+

Common Smart Submunition (FY04-09)
- Next generation smart submunition
- High kill probability against threat spectrum incl APS
- Application across munitions/missiles(≥120mm) & UAVs
- Supports Air Force “Area Dominance” via MOA

~$38M

~$35M

$60M

USMC Interest expressed

Navy Interest expressed

Army Funding

$M = Army Funding
Application of World-Class M&S Tools is Dramatically Enhancing the Way We Design and Assess Products/Processes
In Summary....ARDEC/Picatinny...

- Established “Center of Mass” for Armament Systems and Munitions for Joint Services
- Proven track record of rapid transition of technology to the field
- Modernizing R&D facilities maintaining world-class capabilities
- Developing new concepts/technologies to enhance warfighter capabilities
- Demonstrating future warfighting capabilities today!

ARDEC/Picatinny……..

Products, people, and processes enabling our ultimate customer, the soldier, to “take care of business” throughout the spectrum of conflict!